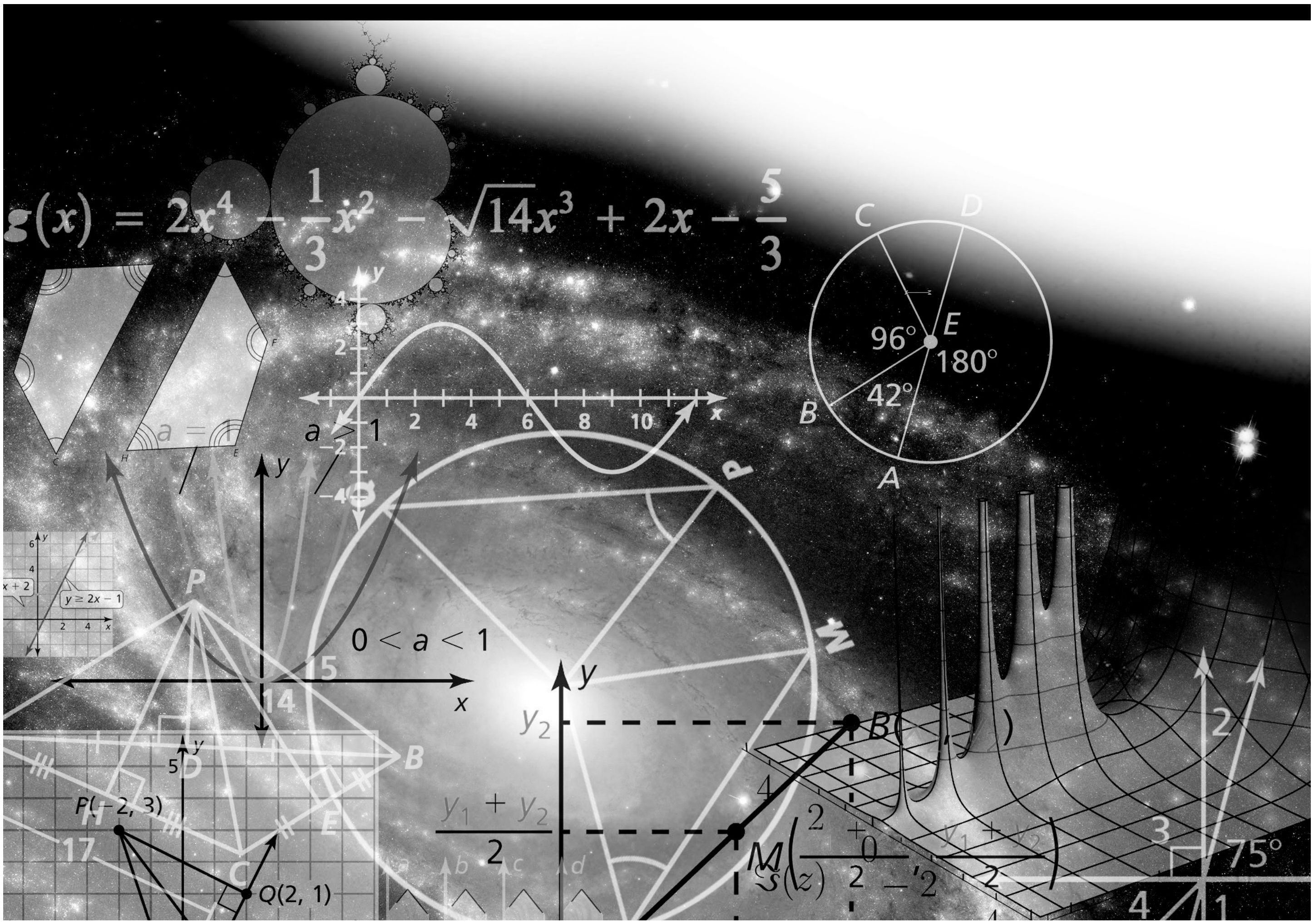
CHAPTER 8
Graphing Quadratic Functions



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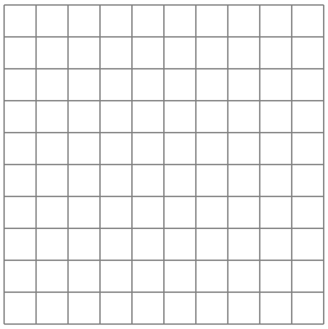
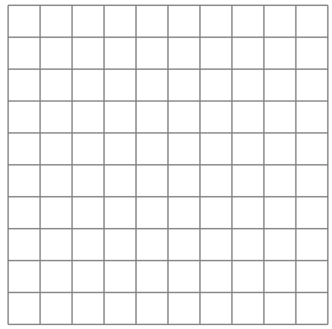
Chapter 8 Maintaining Mathematical Proficiency

Graph the linear equation.

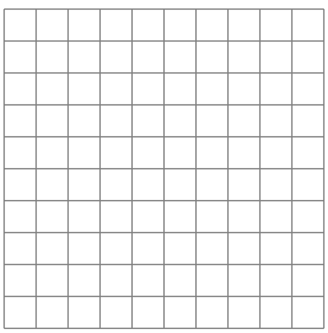
1. $y = 4x - 5$



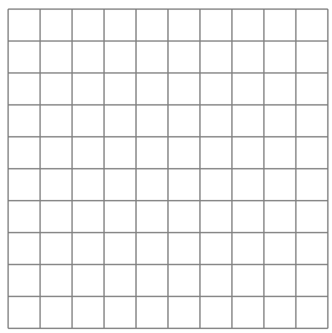
2. $y = -2x + 3$



3. $y = \frac{1}{2}x + 3$



4. $y = -x + 2$



Evaluate the expression when $x = -4$.

5. $2x^2 + 8$

6. $-x^2 + 3x - 4$

7. $-3x^2 - 4$

8. $5x^2 - x + 8$

9. $4x^2 - 8x$

10. $6x^2 - 5x + 3$

11. $-2x^2 + 4x + 4$

12. $3x^2 + 2x + 2$

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8.1 Graphing $f(x) = ax^2$

For use with Exploration 8.1

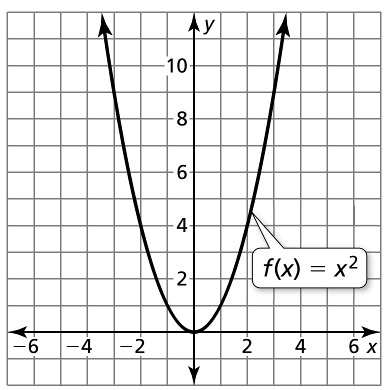
Essential Question What are some of the characteristics of the graph of a quadratic function of the form $f(x) = ax^2$?

1 EXPLORATION: Graphing Quadratic Functions

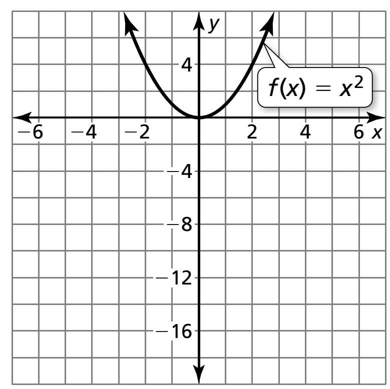
Go to *BigIdeasMath.com* for an interactive tool to investigate this exploration.

Work with a partner. Graph each quadratic function. Compare each graph to the graph of $f(x) = x^2$.

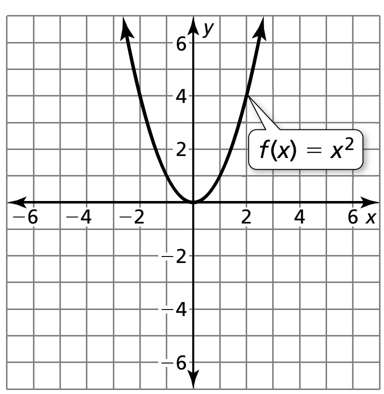
a. $g(x) = 3x^2$



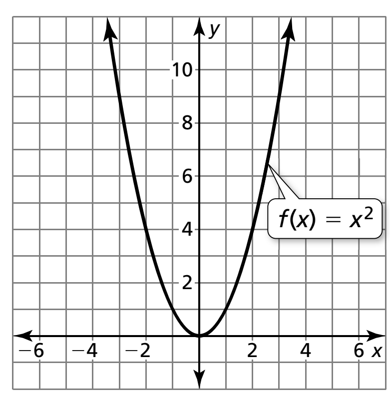
b. $g(x) = -5x^2$



c. $g(x) = -0.2x^2$



d. $g(x) = \frac{1}{10}x^2$

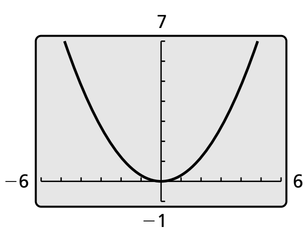


Communicate Your Answer

2. What are some of the characteristics of the graph of a quadratic function of the form $f(x) = ax^2$?

3. How does the value of a affect the graph of $f(x) = ax^2$? Consider $0 < a < 1$, $a > 1$, $-1 < a < 0$, and $a < -1$. Use a graphing calculator to verify your answers.

4. The figure shows the graph of a quadratic function of the form $y = ax^2$. Which of the intervals in Question 3 describes the value of a? Explain your reasoning.



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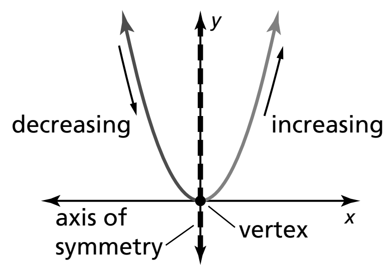
8.1 Practice
For use after Lesson 8.1

Core Concepts

Characteristics of Quadratic Functions

The *parent quadratic function* is $f(x) = x^2$. The graphs of all other quadratic functions are *transformations* of the graph of the parent quadratic function.

The lowest point on a parabola that opens up or the highest point on a parabola that opens down is the **vertex.** The vertex of the graph of $f(x) = x^2$ is (0, 0).

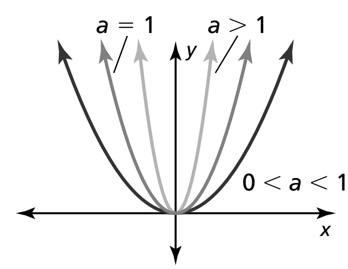


The vertical line that divides the parabola into two symmetric parts is the **axis of symmetry.** The axis of symmetry passes through the vertex. For the graph of $f(x) = x^2$, the axis of symmetry is the y-axis, or $x = 0$.

Notes:

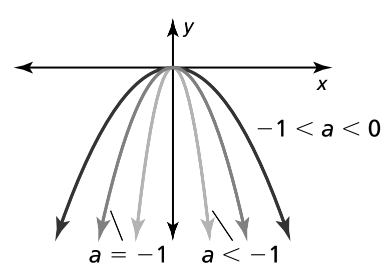
Graphing $f(x) = ax^2$ When $a > 0$

- When $0 < a < 1$, the graph of $f(x) = ax^2$ is a vertical shrink of the graph of $f(x) = x^2$.
- When $a > 1$, the graph of $f(x) = ax^2$ is a vertical stretch of the graph of $f(x) = x^2$.



Graphing $f(x) = ax^2$ When $a < 0$

- When $-1 < a < 0$, the graph of $f(x) = ax^2$ is a vertical shrink with a reflection in the x-axis of the graph of $f(x) = x^2$.
- When $a < -1$, the graph of $f(x) = ax^2$ is a vertical stretch with a reflection in the x-axis of the graph of $f(x) = x^2$.



Notes:

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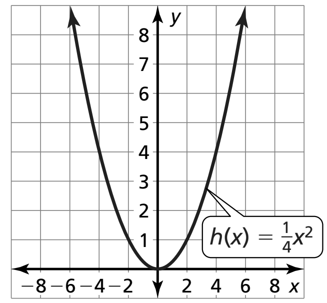
Worked-Out Examples

Example #1

Graph the function. Compare the graph to the graph of f(x) = x².

$h(x) = \frac{1}{4}x^2$

x	-4	-2	0	2	4
$h(x)$	4	1	0	1	4



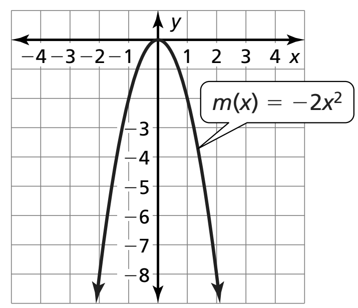
Both graphs open up and have the same vertex, (0, 0), and the same axis of symmetry, $x = 0$, but the graph of h is wider than the graph of f. So, the graph of h is a vertical shrink by a factor of $\frac{1}{4}$ of the graph of f.

Example #2

Graph the function. Compare the graph to the graph of f(x) = x².

$m(x) = -2x^2$

x	-2	-1	0	1	2
$m(x)$	-8	-2	0	-2	-8

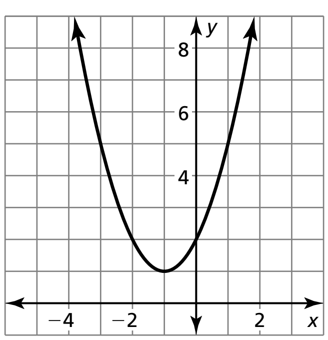


The graphs have the same vertex, (0, 0), and the same axis of symmetry, $x = 0$, but the graph of m opens down and is narrower than the graph of f. So, the graph of m is a vertical stretch by a factor of 2 and a reflection in the x-axis of the graph of f.

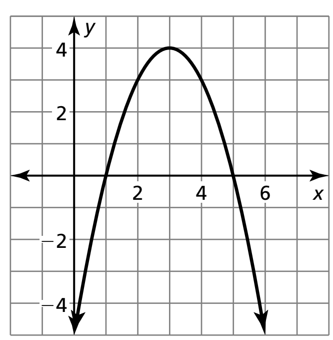
Practice A

In Exercises 1 and 2, identify characteristics of the quadratic function and its graph.

1.



2.



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8.1 Practice (continued)

In Exercises 3–8, graph the function. Compare the graph to the graph of $f(x) = x^2$.

3. $g(x) = 5x^2$

4. $m(x) = -4x^2$

5. $k(x) = -x^2$

6. $l(x) = -7x^2$

7. $n(x) = -\frac{1}{5}x^2$

8. $p(x) = 0.6x^2$

In Exercises 9 and 10, determine whether the statement is *always, sometimes,* or *never* true. Explain your reasoning.

9. The graph of $g(x) = ax^2$ is wider than the graph of $f(x) = x^2$ when $a > 0$.

10. The graph of $g(x) = ax^2$ is narrower than the graph of $f(x) = x^2$ when $|a| < 1$.

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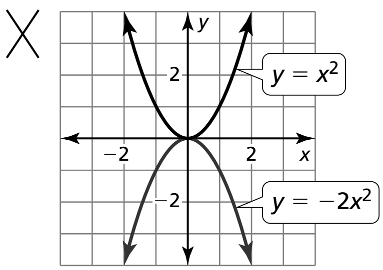
Practice B

In Exercises 1–6, graph the function. Compare the graph to the graph of $f(x) = x^2$.

1. $g(x) = 7x^2$ **2.** $h(x) = 0.25x^2$ **3.** $j(x) = \frac{7}{2}x^2$

4. $g(x) = -\frac{5}{3}x^2$ **5.** $k(x) = -\frac{3}{4}x^2$ **6.** $n(x) = -0.4x^2$

7. Describe and correct the error in graphing and comparing $y = x^2$ and $y = -2x^2$.



The graphs have the same vertex and the same axis of symmetry. The graph of $y = -2x^2$ is a reflection in the x-axis of the graph of $y = x^2$.

8. The arch support of a bridge can be modeled by $y = -\frac{1}{300}x^2$, where x and y are measured in feet.

a. The width of the arch is 900 feet. Describe the domain of the function. Explain.

b. Graph the function using the domain in part (a). Find the height of the arch.

9. A parabola opens down and passes through the points $(-3, 4)$ and $(1, -2)$. How do you know that $(-3, 4)$ could be the vertex?

10. Given the parabola $f(x) = ax^2$.

a. Find the value of a when the graph passes through $(3, -1)$ and $a < 0$.

b. Find the value of a when the graph passes through $(3, -1)$ and $a > 0$. Explain.